

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

RIPARIAN FOREST BUFFER

(Acre)

CODE 391

DEFINITION

An area of predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

PURPOSES

- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.
- Create shade to lower water temperatures to improve habitat for aquatic organisms.
- Provide a source of detritus and large woody debris for aquatic organisms and habitat for wildlife.
- Provide protection against scour erosion within the floodplain.
- Restore natural riparian plant communities.
- Moderate winter temperatures to reduce freezing of aquatic over-wintering habitats.
- To increase carbon storage.
- Provide a harvestable crop of timber, fiber, forage, fruit, or other crops consistent with other intended purposes.

CONDITIONS WHERE PRACTICE APPLIES

On stable areas adjacent to permanent or intermittent streams, lakes, ponds, wetlands and areas with ground water recharge that are capable of supporting woody vegetation.

This practice does not apply on forest lands. (See Filter Strip - Code 393).

The Riparian Forest Buffer is a component of a planned land management system that includes nutrient, pesticide, runoff, sediment, and erosion control practices as needed.

CRITERIA

General Criteria Applicable to All Purposes Named Above

The location, layout, width, length and density of woody plants in the riparian forest buffer will be designed to accomplish the intended purpose and function. See General Specifications for required plant densities for buffer plantings.

Dominant vegetation will consist of existing, naturally regenerated, or planted trees and shrubs suited to the site and the intended purpose. Locally native species will be used where available. Plantings will consist of two or more species with individual plants suited to the seasonal variation of soil moisture within the planned buffer (see Figure 1 on page 2). Plant types and species shall be selected based on their compatibility in growth rates and shade tolerance. Select species from the Plant List, Table 1, located in General Specifications, the NRCS standard for Tree/Shrub Establishment (Code 612), or trees and shrubs listed in the woodland suitability or potential native plant community sections of the soil interpretations record.

All buffers will consist of a Zone 1 that begins at the normal water line, or at the upper edge of the active streambank (if incised), or shore, and extends a minimum distance of 15 feet, measured horizontally on a line perpendicular to the watercourse or water body (see exception relating to maintenance travelways).

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

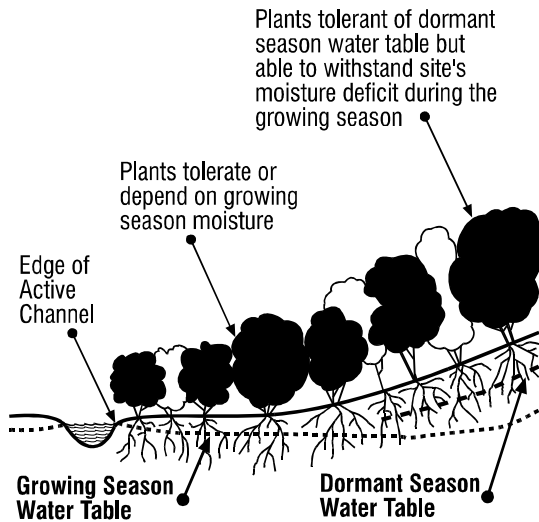


Figure 1. Plant adaptation to soil moisture.

Occasional removal of some tree and shrub products is permitted in Zone 1 provided the intended purpose is not compromised by the loss of vegetation or harvesting disturbance and provision is made to re-establish the trees or shrubs. Felling and skidding of trees shall be directed away from the watercourse or water body. Skidding will be done in a manner to prevent creation of ephemeral channels perpendicular to the stream.

Logging in the buffer will comply with forest practices guidelines. Logging and other overland equipment shall be excluded from Zone 1, except for stream crossings and stabilization work. For unstable areas, streambank protection measures will be planned and conducted as needed in accordance with the standard for Streambank and Shoreline Protection (Code 580).

An adequate upstream or adjacent seed source must be present when using natural regeneration to establish a buffer.

Necessary site preparation and planting for establishing new buffers shall be done at a time and manner to insure survival and growth of selected species. Refer to General Specifications for care, handling, and planting requirements for woody planting stock.

Only viable, high quality, and adapted planting stock will be used.

The method of planting for new buffers shall include hand or machine planting techniques

and be suited to achieving proper depths and placement of planting stock roots.

Site preparation shall be sufficient for establishment and growth of selected species and be done in a manner that does not compromise the intended purpose. See General Specifications for detailed site preparation procedures.

Livestock shall be excluded to achieve and maintain the intended purpose. Stream crossings and livestock watering facilities shall be located and designed to minimize impact on buffer vegetation and shall be fenced. See standard for Fencing (Code 382).

Harmful pests present on the site will be controlled or eliminated as necessary to achieve and maintain the intended purpose.

For optimal carbon storage, select plant species that are adapted to the site to assure strong health and vigor and plant the full stocking rate for the site.

Comply with applicable federal, state and local laws and regulations during the installation, operation (including harvesting activities) and maintenance of this practice.

Initial plant-to-plant densities for trees and shrubs will depend on their potential height at 20 years of age. Heights may be estimated based on: 1) performance of the individual species (or comparable species) in nearby areas on similar sites, or 2) predetermined and documented heights using Conservation Tree/Shrub Suitability Groups, Section II of the Field Office Technical Guide. Planting density specifications are:

Plant Types/Heights:	Plant-to-Plant Spacing in Feet:
• Shrubs less than 10 feet in height	3 to 6
• Shrubs and trees from 10 to 25 feet in height (includes columnar trees)	5 to 8
• Trees greater than 25 feet in height	6 to 15

Plants may be selected from Table 1, the NRCS standard for Tree and Shrub Establishment (Code 612), or soil interpretations records list of

woody plant species (trees and shrubs) commonly associated with and suited to riparian areas. Virginia pine and Fraser Fir will not be used for riparian forest buffers.

Planting sites shall be properly prepared in accordance with the standard for Forest Site Preparation (Code 490) and the additional methods that follow. Site preparation shall be based on soil types and vegetative conditions. Avoid sites that have had recent application of pesticides harmful to woody species to be planted. If pesticides are used, apply only when needed and handle and dispose of properly and within federal, state and local regulations. Follow label directions and heed all precautions listed on the container.

Based on site conditions, procedures include:

Tillable sites with loamy/clayey soils

Sod sites - Sod may be killed by non-selective herbicides the year previous to planting stock. Plant stock in the residue. The site must be visited in mid-summer of the year prior to planting to assess the nature and extent of competing vegetation. The timing and choice of herbicides will be determined based on this site visit.

When hand planting, scalp or strip an area at least 3 feet in diameter and two-to-four inches deep. Place plants in the center of the scalped area.

Small grain or row crop sites - If the site is in a clean tilled small grain, corn, or similar crop, and it is reasonably free of weeds, plant stock in the stubble without prior preparation. If the site is weedy, herbicide treatments may be needed in the summer prior to planting.

Problem sites and/or erosive sites (including sites with undesirable brushy or herbaceous species)

On sites where it is not practical or possible to operate equipment (steepness, rockiness, etc.), the methods listed below may be used. Sites with undesirable brush will need initial treatments that physically removes and kills the brush species to facilitate planting of desired stock and prevent reencroachment of the brush. Suitable methods include hand-cutting and removal, brush hogging, brush-blading, or other equivalent procedure with repeated treatment or use of herbicides to control resprouting.

Machine or hand scalp an area at least 36 inches in diameter with subsequent plant placement in the center of the scalped area.

Kill the vegetation in a 36-inch diameter or larger area or in a 36-inch or wider strip with a non-selective herbicide the year prior to planting and plant in the center or along the centerline of the treated area.

Additional Criteria to Reduce Excess Amounts of Sediment, Organic Material, Nutrients, and Pesticides in Surface Runoff and Reduce Excess Nutrients and Other Chemicals in Shallow Groundwater Flow

An additional strip or area of land, Zone 2, will begin at the edge and up-gradient of Zone 1 and extend a minimum distance of 20 feet, measured horizontally on a line perpendicular to the watercourse or water body. The minimum combined width for any site will be 35 feet (15 ft. Zone 1 and 20 ft. Zone 2). The combined width of Zones 1 and 2 will be increased to 100 feet or 30 percent of the geomorphic (active) floodplain, whichever is less. (Note: The geomorphic active floodplain may be narrower than the valley bottom if the valley formed under different hydrologic conditions.) Figure 2 illustrates examples of Zones 1 and 2 widths for watercourses and water bodies.

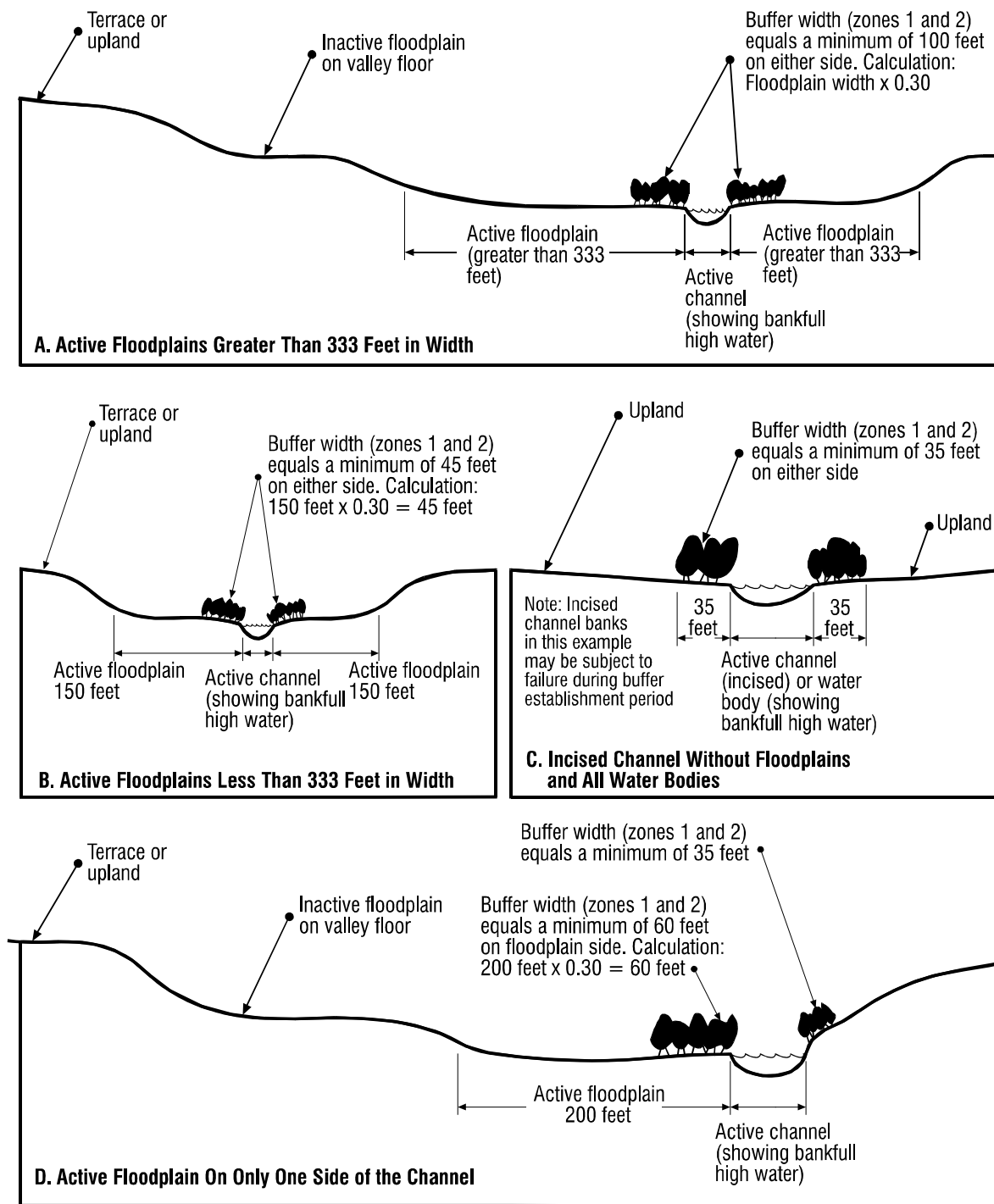


Figure 2. Examples of riparian forest buffer widths for watercourses and water bodies.

In eastern North Carolina travelways for maintenance are required to be maintained immediately adjacent to PL-566 Watershed project channels in accordance with agreements between NRCS and sponsoring drainage districts and corporations. North Carolina General Statute 156 requires sponsoring organizations to maintain drainage by mowing and removal of sediment as needed. Additionally, individual landowners require access to some drainage channels for periodic dip-out and other maintenance.

In such cases, where the primary purpose of the buffer is to reduce nutrients and improve water quality, the buffer (both Zones 1 and 2) may be established on the field side of a vegetated maintenance travelway.

The width of travelway setback for landowner-maintained channels shall be a maximum of 30 feet from the top of the channel bank. For channels maintained by drainage districts or corporations, the maximum setback shall be the width of travelway required for maintenance as designated in the Operation and Maintenance agreement or as-built engineering plans.

Maintenance travelways shall be located on the north and east side of channels, where possible, to minimize shading of the channel. Travelways will be stabilized to eliminate soil erosion.

Zone 2 width may be increased where practical up to 120 feet in high sediment or nutrient producing areas - exceeds T or very high (over 100) P indices.

Criteria for Zone 1 shall apply to Zone 2 except that removal of tree and shrub products in Zone 2 such as timber, nuts and fruit is permitted on a periodic and regular basis provided the trees and shrubs are replaced and the intended purpose is not compromised by loss of vegetation or harvesting disturbance. Old, slow-growing trees in Zone 2 will be removed to maintain a healthy stand of fast growing trees.

Concentrated flow, erosion, excessive sheet and rill erosion or mass soil movement shall be controlled in the up-gradient area immediately adjacent to Zone 2 prior to establishment of the riparian forest buffer (see Figure 3). The Filter Strip standard (Code 393) shall be used.

Riparian forest buffers will be designed to maximize sheet flow and infiltration and impede concentrated flow. Concentrated flows needing treatment must be converted to sheet flow or

subsurface flows up-gradient from Zone 2 or within the upper one-third of Zone 2 through the use of practices such as shaped field borders with closely spaced outlet pipes or level spreaders.

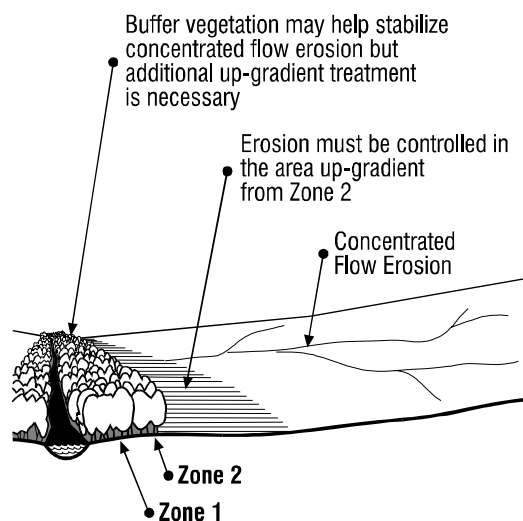


Figure 3. Control of concentrated flow erosion.

All forest harvesting operations shall be in compliance with North Carolina's Forest Practices Guidelines related to Water Quality.

Additional Criteria to Create Shade to Lower Water Temperatures to Improve Habitat for Aquatic Organisms

A buffer for lowering warm-season water temperatures shall consist of at least Zone 1.

Buffers shall be established or maintained on south and west sides of watercourses and bodies insofar as practical. The buffer vegetation shall be established to achieve at least 50 percent crown cover with average canopy heights equal to or greater than the width of the watercourse or 30 feet for water bodies. See Figure 4 on next page.

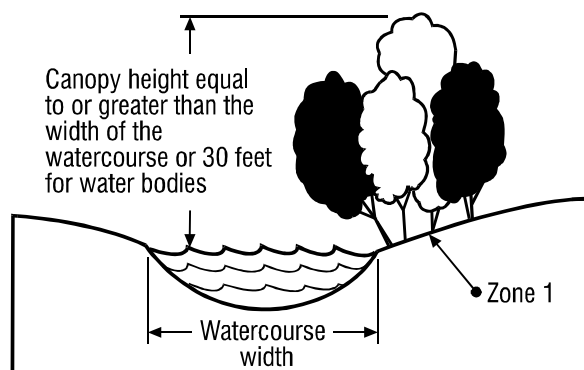


Figure 4. Canopy height for water temperature control.

Buffer species shall include those species from the listed sources with sufficient height potential. Place drooping or wide-crowned trees and shrubs nearest the watercourse or body. Shoreline or channel relief (e.g., deeply incised channels) and topographic shading will be taken into account in selecting species.

Additional Criteria to Provide a Source of Detritus and Large Woody Debris for Aquatic Organisms and Habitat for Wildlife

Within Zone 1 as a minimum, establish, favor or manage species capable of producing stems and limbs of sufficient size to provide an eventual source of large woody debris for in-stream habitat for fish and other aquatic organisms.

Width of Zone 1 and/or Zone 2 will be expanded to meet the minimum requirements of the wildlife or aquatic species and associated communities of concern. See buffer width guide in North Carolina specifications.

Plant selection and design in expanded buffer widths will address the food and habitat needs of targeted wildlife species.

Buffer widths for the selected wildlife species below include the sum of buffer widths on one or both sides of water courses or water bodies and may extend beyond riparian boundaries (in such cases refer to Tree/Shrub Establishment, Code 612, for design of upland forests). These widths are to be used as guidelines where the objective is to provide for the target species.

Species:	Desired Width (Feet):
• Bald eagle	750
• Cavity nesting ducks, heron rookery	600
• Common loon, pileated woodpecker	450
• Beaver, dabbling ducks, mink, salmonids	300
• Deer	200
• Frog, salamander	100

CONSIDERATIONS

Wide widths (75 feet or more) are preferred. They are more effective for the listed purposes and more feasible to manage. Narrower widths within this standard recognize the value of streamside land for farming and limited bottomland acreage in many piedmont and mountain locations.

The severity of bank erosion and its influence on existing or potential riparian trees and shrubs should be assessed. Watershed-level treatment or bank stability activities may be needed before establishing a riparian forest buffer.

Expected upstream urbanization that may affect streamflow during storm events should be considered when selecting vegetation.

Complex ownership patterns of riparian areas may require group planning for proper buffer design, function and management.

Where ephemeral, concentrated flow or sheet and rill erosion and sedimentation is a concern in the area up-gradient of Zone 2, adequate erosion control measures should be applied on the adjacent field. Consider the application of a vegetated filter strip consisting of grasses and forbs. Stiff-stemmed grasses established at the up-gradient edge of Zone 2 will accelerate deposition of sediment. See Figure 5 on next page. When concentrated flow or excessive sheet and rill erosion and sedimentation cannot be

controlled vegetatively, consider structural or mechanical treatments.

Where direct runoff of animal waste is likely, nutrient management must be applied on adjacent fields. Forest buffers should not be planned as a substitute for a management system on adjacent fields.

Use of this practice without other nutrient, pesticide, sediment, and erosion control practices can result in adverse impacts on buffer vegetation, and hydraulics. The expected adverse impacts could be high maintenance costs, frequent need for re-establishment of vegetation, and the delivery of excess nutrients, sediment and other potential pollutants through the buffer by concentrated flows.

Joining of existing and new buffers increase the continuity of cover and will further moderate water temperatures. A mix of species with growth forms that are tall and wide-crowned or drooping will increase moderation effects. For watercourses, buffers established on both sides will often enhance buffer effectiveness.

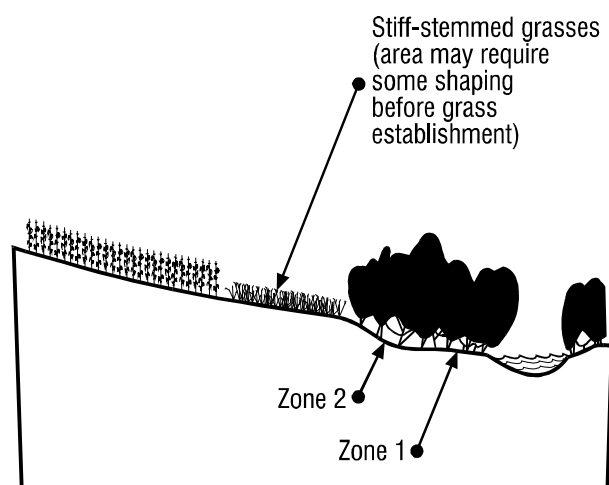


Figure 5. Sediment-trapping above zone 2.

Favor a diversity of tree and shrub species that are native non-invasive, and have multiple values such as those suited for timber, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Consider species that re-sprout when establishing new rows nearest to watercourses or bodies. See NRCS Biology Technical Reference, Use of Native Plants by Wildlife Species (tables).

Tree and shrub species which may be alternate hosts to undesirable pests or that may be

considered noxious or undesirable should be avoided. Species diversity should be considered to avoid loss of function due to species-specific pests. Allelopathic impacts of plants should be considered.

The location, layout and density of the buffer should complement natural features. Avoid layouts and locations that would concentrate flood flows or return flows. Low, flexible-stemmed shrubs will minimize obstruction of local flood flows.

Consider the positive and negative impacts beaver, muskrat, deer, rabbits and other local species may have on the successful management of the riparian and stream system.

Consider the type of human use (rural, suburban, urban) and the aesthetic, social and safety aspects of the area to determine the vegetation selection, arrangement and management. For example, avoid shrubs that block desirable views. Pruning low tree branches near recreation trails allows for ease of use.

Species selection should consider aesthetics including seasonal foliage color, showy flowers and fruit, foliage texture, form and branching habit. The layout and design should be appropriate for the setting as determined by adjacent land uses.

PLANS AND SPECIFICATIONS

Specifications for this practice shall be prepared for each site and recorded using approved specifications sheets, job sheets, technical notes, narrative statements in the conservation plan, references to enclosed plans from other agencies, or other acceptable documentation.

Minimum documentation for this practice includes:

- Species to be planted
- Plant spacing
- Site preparation and planting methods
- Season of the year to be performed
- Soil amendments
- Competition control
- Statement requiring compliance with all federal, state, and local laws
- Operation and maintenance requirements

OPERATION AND MAINTENANCE

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life. These actions include normal

repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance):

- The riparian forest buffer will be inspected periodically, and protected from livestock damage and destructive fire.
- Buffer with trees to be established through natural regeneration should be inspected periodically until establishment of desired species and stocking is ensured.
- Remove debris and sediment from all structures as needed. Inspect after heavy storms. Walk parallel to the stream through each zone of the buffer at least annually. Check for areas where water is concentrating. Disperse concentrated flow by appropriate measures, including placement and repositioning of debris.
- Excess use of fertilizers, pesticides, or other chemicals, vehicular traffic or excessive animal traffic, and the removal or disturbance of vegetation and litter inconsistent with erosion control and buffering objectives must be avoided.
- Whenever possible, stable debris should be conserved except where fallen trees and debris create unstable streambanks.
- Material removed from the stream should be deposited a sufficient distance away from the stream so that it will not be re-deposited by high water into the stream.
- Where debris dams must be removed, useful stable portions which provide fish habitat should be retained when possible.
- Vegetation, undergrowth, forest floor, duff layer, and leaf litter shall remain undisturbed except for removal of trees that represent a hazard to streambank stability, and individual trees of high economic value in Zone 1.
- Harvesting should be planned for Zone 2 as needed to meet landowner wildlife objectives, provide for maximum nutrient uptake, and remove nutrients and pollutants sequestered in the wood of trees.
- Site preparation consistent with good forest management practices may be used within Zone 2 for regeneration purposes.
- Replacement of dead trees or shrubs and control of undesirable vegetative competition will be continued until the buffer is, or progresses to, a fully functional condition.
- As applicable, adequate erosion control shall be maintained in the up-gradient area immediately adjacent to Zone 2 to maintain buffer function.
- Any removals of tree and shrub products shall be conducted in a manner that maintains the intended purpose and in accordance with forest practices guidelines.
- For purposes of moderating water temperatures and providing detritus and large woody debris, riparian forest buffer management must maintain a minimum of 50 percent canopy cover in Zone 1.
- For providing habitat and corridors for wildlife, manage the buffer to favor food, shelter and nesting cover that would satisfy the habitat requirements of the indicator or target wildlife. See NRCS Biology Technical Reference.
- Any use of fertilizers, mechanical treatments, prescribed burning, pesticides, and other chemicals to assure buffer function shall not compromise the intended purpose.
- Additional operation and maintenance requirements shall be developed on a site-specific basis to assure performance of the practice as intended.

REFERENCES

U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry, 1991. Riparian Forest Buffers -- Function and Design for Protection and Enhancement of Water Resources. NA-PR-07-91. Prepared by: Monte E. Seehorn, Atlanta, GA.

U.S. Department of Agriculture, Forest Service, Southern Region, 1992. Stream Habitat Improvement Handbook. Tech. Publ. R8-TP 16. Prepared by: David J. Welsch. Radnor, PA.

TABLE 1. PLANT LIST: Species Suitable For Planting In Riparian Forest Buffers

		Spacing (Number / Acre)	
Species: Softwoods (Conifers)	Geographic Region*	Minimum	Maximum
Atlantic White-Cedar	CP	680 (8X8)	1210 (6X6)
Bald Cypress	CP, Pied	680 (8X8)	1210 (6X6)
Loblolly Pine	CP, Pied	435 (10X10)	622 (7X10)
Longleaf Pine	CP, Pied	622 (7X10)	800 (6X9)
Pond Pine	CP	435 (10X10)	622 (7X10)
Eastern White Pine	Mtns.	300 (12X12)	622 (7X10)
		Spacing (Number / Acre)	
Species: Hardwoods	Geographic Region*	Minimum	Maximum
Yellow-Poplar	CP, Pied, Mtns	302 (12X12)	435 (10X10)
Sycamore	CP, Pied	302 (12X12)	435 (10X10)
Sweetgum	CP, Pied	302 (12X12)	435 (10X10)
Green Ash	CP, Pied	302 (12X12)	435 (10X10)
White Ash	Pied	302 (12X12)	435 (10X10)
Tupelo Gum	CP	302 (12X12)	435 (10X10)
Cherrybark Oak	CP	302 (12X12)	435 (10X10)
Swamp Chestnut Oak	CP	302 (12X12)	435 (10X10)
Willow/Water Oaks	CP, Pied	302 (12X12)	435 (10X10)
Northern Red Oak	Mtns	302 (12X12)	435 (10X10)
Overcup Oak	CP	302 (12X12)	435 (10X10)
Black Walnut	Mtns, Pied	200 (15X15)	110 (20X20)
Cottonwood	CP, Pied	302 (12X12)	435 (10X10)
Species: Shrubs	Species: Small Trees		
Shrub lespedeza	Dogwood		
Blueberry	Pawpaw		
	Serviceberry		
	Crabapple		
	Black Haw		

*CP = Coastal Plain; Pied = Piedmont; Mtns = Mountains

Hardwood species are site specific. Select species best suited to the soil, drainage, slope elevation and other site factors.

Other tree species may be acceptable if site conditions dictate and they are approved by the local N.C. Division of Forest Shrub suitable to previously farmed wetland soils that provide food or cover to wildlife. Specific site recommendations vary according to soil and moisture characteristics.

Shrubs suitable to previously farmed wetland soils that provide food or cover to wildlife. Specific site recommendations vary according to soil and moisture characteristics.